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In re Application of:	)	
	:	Examiner: Alan D. Diamond
HIDEHISA MAKITA, ET AL.	)	
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Application No.: 10/658,387	)	
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Filed: September 10, 2003	)	
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For: SOLAR CELL MODULE-MOUNTING STRUCTURE AND SOLAR CELL MODULE ARRAY	)	September 7, 2004 (Tuesday after Labor Day holiday)

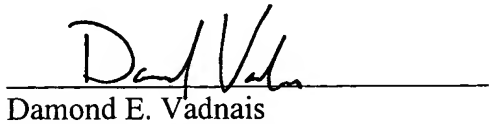
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

LETTER TRANSMITTING SWORN TRANSLATIONS

Sir:

Enclosed herewith are sworn translations of Japan 2002-090187, filed March 28, 2002, and Japan 2003-064313, filed March 11, 2003, from which applications the subject application claims priority under 35 U.S.C. § 119. See MPEP § 201.15.

Applicants' undersigned attorney may be reached in our Washington, D.C. office by telephone at (202) 530-1010. All correspondence should continue to be directed to our address listed below.



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Appln. No 10/658,387
Filing Date 9/10/03
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DECLARATION

I, Norimichi Takanashi, a Japanese Patent Attorney registered No. 10280, of Okabe International Patent Office at No. 602, Fuji Bldg., 2-3, Marunouchi 3-chome, Chiyoda-ku, Tokyo, Japan, hereby declare that I have a thorough knowledge of Japanese and English languages, and that the attached pages contain a correct translation into English of the priority documents of Japanese Patent Application No. 2002-090187 filed on March 28, 2002 in the name of CANON KABUSHIKI KAISHA.

I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made, are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

signed this 26th day of August, 2004

Norimichi Takanashi

NORIMICHI TAKANASHI

PATENT OFFICE
JAPANESE GOVERNMENT

This is to certify that the annexed is a true copy of the following application as filed with this Office.

Date of Application: March 28, 2002

Application Number: Japanese Patent Application
No. 2002-090187

Applicant(s): CANON KABUSHIKI KAISHA

September 8, 2003

Commissioner,
Patent Office YASUO IMAI (Seal)

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2002-090187

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[Date] March 28, 2002

[Addressed to] Commissioner, Patent Office

[International Classification] H01L 31/00

[Title of the Invention] SOLAR CELL-MOUNTING STRUCTURE, SOLAR CELL ARRAY AND PHOTOVOLTAIC POWER GENERATION SYSTEM

[Number of the Claims] 11

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[Material] Abstract 1

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[TITLE OF THE INVENTION]

SOLAR CELL-MOUNTING STRUCTURE, SOLAR CELL ARRAY AND PHOTOVOLTAIC POWER GENERATION SYSTEM

[WHAT IS CLAIMED IS:]

[Claim 1] A solar cell-mounting structure, in which a plate-shaped member has a solar cell fixed on one surface thereof, the solar cell having a uncovered conductor constituting a part of an electrical output path, said plate-shaped member is placed on an installation surface so that one side of said plate-shaped member is in contact with the installation surface, a surface of said plate-shaped member opposite to the solar cell-fixing surface is in contact with a first support member, and out of surfaces including said one side of said plate-shaped member, at least a part of the surfaces in no contact with said first support member is in contact with a second support member.

[Claim 2] The solar cell-mounting structure according to claim 1, wherein said second support member is a support member in contact with a surface of a second plate-shaped member opposite to a solar cell-fixing surface of said second plate-shaped member to support said second plate-shaped member.

[Claim 3] The solar cell-mounting structure according to claim 1 or 2, wherein said plate-shaped

member is cast from a concrete material.

[Claim 4] The solar cell-mounting structure according to any one of claims 1 to 3, wherein said plate-shaped member and said support member have the same shape and are made of the same material.

[Claim 5] The solar cell-mounting structure according to any one of claims 1 to 4, wherein said solar cell is fixed to said plate-shaped member with an adhesive.

[Claim 6] The solar cell-mounting structure according to claim 5, wherein said adhesive is an elastic adhesive.

[Claim 7] The solar cell-mounting structure according to claim 5 or 6, wherein said adhesive is provided at a surrounding part of said solar cell.

[Claim 8] The solar cell-mounting structure according to any one of claims 1 to 7, wherein said solar cell is composed of amorphous silicon formed on a stainless steel substrate.

[Claim 9] The solar cell-mounting structure according to any one of claims 1 to 8, wherein an insulating member is placed between said one side of the plate-shaped member to be brought into contact with said installation surface and said installation surface.

[Claim 10] A solar cell array comprising the solar cell-mounting structure according to any one of

claims 1 to 9.

[Claim 11] A photovoltaic power generation system comprising a solar cell array according to claim 10 and a power conditioner.

[DETAILED DESCRIPTION OF THE INVENTION]

[0001]

[Technical Field of the Invention]

The present invention relates to a solar cell-mounting structure, a solar cell array and a photovoltaic power generation system.

Related Background Art

[0002]

[Background Art]

The raised awareness of environmental issues has been spreading globally. Particularly, the concern about global warming phenomenon associated with CO_2 emission is serious, and the desire for clean energy has been increasing. At present, a solar cell can be expected as a clean energy source for safety and easy handling.

[0003]

Recently, various types of forms for mounting the solar cell other than a roof-mounting type have been proposed as described below.

[0004]

FIG. 2 is a schematic view of the solar cell

structure using a conventional rack-mounted-type solar cell. In FIG. 2, numeral 2001 denotes a solar cell module; 2002 denotes a concrete foundation; 2003 denotes a frame; and 2004 denotes an anchor.

[0005]

The structure of this type solar cell is characterized by a structure in which the solar cell is incorporated into a frame such as an aluminum frame to maintain structural strengths, the front surface of a photovoltaic element is sealed by glass and the bottom surface thereof filled and sealed by plastics to secure sufficient electric insulation properties and weathering resistance, and anchors are hammered into the ground to increase wind pressure resistance strength of the rack itself. The solar cell of this type has come into widespread use as the most typical one at present.

[0006]

On the other hand, as a base material for the rack and the solar cell, a concrete member has been paying attention recently because of its low price.

[0007]

An example shown in FIG. 3 is known as the one in which a concrete member is used as the rack instead of a conventional frame rack.

[0008]

FIG. 3 illustrates an example of the rack

comprised of a lightweight cellular concrete tailored for a solar cell described in Japanese Utility Model Laid-Open No. 5-57857. In FIG. 3, numeral 3001 denotes a solar cell module; 3002 denotes a lightweight cellular concrete rack; and 3003 denotes a fastener. According to the construction, a fitting device may be fixed with a nail or the like on the concrete rack, and the rack itself forms an inclined surface for mounting the solar cell only by placing the rack on the ground, thereby improving workability.

[0009]

[Problem to be solved by the Invention]

In the conventional solar cell-mounting structure, the electroactive portion of a solar cell is covered with an insulating member so as not to be exposed to the environment, for the purpose of securing sufficient electric insulation properties and weathering resistance. The solar cell is provided with a cable or connector for electrically connecting to an adjacent solar cell, and as the connector a water-proof type connector is used so as not to generate a leakage current when an electrical connection part is wetted by rain water or the like.

[0010]

Thus, the conventional solar cell used outdoors has the electricoactive portion completely protected from rain water or the like so as to generate no

leakage current.

[0011]

However, the complete protection of the electroactive portion of the solar cell leads to increase of its cost. For example, the conventional solar cell has a structure in which a light-receiving surface and a non-light-receiving surface are completely covered with glass, and the cost of the solar cell is very high.

[0012]

Further, since it is necessary to also perform a complete water-proof treatment on a wiring member by which solar cells are connected, the cost of the connecting member itself becomes high. Of course, since it is necessary to perform a water-proof treatment on a connecting member and the like at the time of construction of the solar cell, there are problems of a poor construction property and a high cost for the construction.

[0013]

Thus, not only the conventional rack-mounted solar cell structure but also the conventional solar cell-mounting structure using a concrete member as the rack has been limited in cost reduction.

[0014]

In view of the above situation, the present inventors have studied on the establishment of an

environment in which a person other than an electrical worker having highly electrical knowledge cannot trespass by a fence or the like as well as the reduction of costs of a photovoltaic power generation system in such an environment, and the inventors have devised the following structure.

[00015]

Firstly, a rectangular plate-shaped member is used as a plate-shaped member for supporting the solar cell, and a support member is used as means for inclining the plate-shaped member for mounting the solar cell, thus providing the inclination required for mounting the solar cell to aim to reduce the cost of the materials of the rack and the cost for construction work.

[0016]

Secondly, the costs are greatly reduced by using a non-insulated type solar cell having an partly exposed electrical path in stead of using the conventional expensive insulated type solar cell module. This is an idea of mounting simply covered photovoltaic element, and it is achieved by using a solar cell composed of a photovoltaic layer formed on a substrate, a resin simply covering only a light-receiving face side of the substrate or only a light-receiving face side and a non-light-receiving face side of the substrate, and an electroactive portion

partly exposed.

[0017]

Thirdly, in addition to use of the non-insulated type solar cell, a uncovered and non-insulated electric wire is used as a cable for taking out a power from a solar cell, thereby achieving reduction of the cost of wring materials at the same time of easy construction.

[0018]

However, when the above non-insulated type solar cell having a partly exposed electrical path was mounted and fixed on a plate-shaped member such as a concrete block and was electrically connected another solar cell, the following problems were found.

[0019]

(Problems on electrical corrosion of exposed portion of electrical path)

Since the non-insulated type solar cell having a structure in which a part of the electroactive portion is exposed to the environment also after construction, when the solar cell is fixed on the plate-shaped member such as a concrete block, after the plate-shaped member contains water due to rain or the like, a resistance between the exposed electrical path and the plate-shaped member and an installation surface (the ground or the like) is reduced to, in some cases, generate a leakage current at the time of

fine weather by the electromotive force of the a solar cell.

[0020]

This leakage current is very small and does not affect on the power generation amount of a solar cell. When the solar cell is arranged outdoors, the electroactive portion, the exposed connecting cable, or the like of one solar cell becomes a counter electrode of the electroactive portion, the exposed connecting cable, or the like of another solar cell, and a voltage is generated between the electroactive portions so that an electrochemical reaction can occur therebetween. A the result, it was found that metal ions were eluted from the electrical path of the insulated type solar cell and the elecroactive portion of a non-insulated electric wire to shorten the life of the solar cell, the non-insulated connecting cable or the like

[0021]

Further, when a back electrode layer or a back reflection layer constituting a solar cell is exposed by an accident or the like at the time of construction, an electrochemical reaction occurs at the time of fine weather immediately after raining, similarly as in the electroactive portions, and in this case it is very highly possible that a metal is eluted from the back electrode layer or the back

reflection layer. As the result, it was found that this generated a problem that peeling of a film from a solar cell rapidly proceeded to remarkably shorten the life of a solar cell.

[0022]

Even in a solar cell covered with an insulator, there is a possibility that the end of the solar cell is injured at the time of construction by mistake, and there is also a possibility that this generates a problem of elution of metal ion from the back electrode layer or the back reflection layer if water permeates through the injury.

[0023]

The inventors considered that the electrical resistance between the plate-shaped member and the installation surface (the ground or the like) could be made large without using a special member, that is, by using a structure in which the plate-shaped member 403 is supported by bring one side of the plate-shaped member into contact with an installation surface 407 as shown in FIG. 4, thereby solving the above-described problems.

[0024]

By the way, when a strong wind hit the plate-shaped member 403 in the direction 401 as shown in FIG. 4, it was found that the following problems generated.

[0025]

(Problem of movement of plate-shaped member by wind pressure)

When a plate-shaped member 403 is installed as shown in FIG. 4, the wind hitting the plate-shaped member 403 in the direction of an arrow 401 generates a force acting in the direction perpendicular to the surface hit by the wind. In other words, a force (lift) lifting the plate-shaped member 403 acts on the fixing-surface 409 of the solar cell 402 and its opposite surface 405, and a force (drag) moving the plate-shaped member 403 laterally acts on the side surface 404. Generally, these forces are calculated as the product of a wind force coefficient (depending on surface properties and an inclination angle), a wind-receiving area and velocity pressure (proportional to the square of wind velocity), and the lift and the drag acting on each plate-shaped member increase in proportion to the square of the wind velocity.

[0026]

Further, when the plate-shaped member 403 is in contact with an installation surface 407 and a support member 406 at one side respectively to be supported as shown in FIG. 4, the area of contact between the installation surface 407 and the plate-shaped member 403 and the area of contact between the

support member 406 and the plate-shaped member 403 are small, thereby resulting in a small frictional force between the plate-shaped member 403 and the installation surface 407. When a force as illustrated in FIG. 4 acts in such a state, the frictional force between the plate-shaped member and the installation surface is further decreased due to the decrease of its own weight by the lift, thereby causing the plate-shaped member to be moved laterally even by a wind having a strength smaller than the wind pressure resistance strength of the plate-shaped member.

[0027]

An object of the present invention is to provide a solar cell-mounting structure which can prevent the lives of a solar cell and an exposed electric wire from being shortened by an electrochemical reaction resulting from a leakage current from a partly exposed electrical path of the solar cell or the electric wire not covered with an insulator, and which can effectively prevent a solar cell-mounting rack from being moved by a wind load; a solar cell array; and a photovoltaic power generation system utilizing the structure.

[0028]

[Means for solving the problems]

The inventors have diligently conducted

research and development and found that the following solar cell-mounting structure is the best.

[0029]

More specifically, the solar cell-mounting structure according to the present invention is characterized in that: in the structure, a plate-shaped member having a solar cell fixed on one surface thereof, the solar cell has a uncovered conductor constituting a part of an electrical output path, the plate-shaped member is placed on an installation surface so that one side of the plate-shaped member is in contact with the installation surface, a surface of the plate-shaped member opposite to the solar cell-fixing surface is in contact with a first support member, and out of surfaces including the one side of the plate-shaped member, at least a part of the surfaces in no contact with the first support member is in contact with a second support member.

[0030]

The solar cell-mounting structure according to the present invention is further characterized in that:

"the above-described second support member is a support member which is in contact with a surface of a second plate-shaped member opposite to a solar cell-fixing surface of the second plate-shaped member

to support the second plate-shaped member";

"the above-described plate-shaped member is cast from a concrete material";

"the above-described plate-shaped member and the above-described support member have the same shape and are made of the same material";

"the above-described solar cell is fixed to the above-described plate-shaped member with an adhesive";

"the above-described adhesive is an elastic adhesive";

"the above-described adhesive is provided at the surrounding part of the above-described solar cell";

"the above-described solar cell is composed of amorphous silicon formed on a stainless steel substrate"; and

"an insulating member is placed between the above-described one side of the plate-shaped member to be brought into contact with the above-described installation surface and the above-described installation surface".

[0031]

In addition, the present invention provides a solar cell array comprising the solar cell-mounting structure according to the present invention, and further a photovoltaic power generation system

comprising the solar cell array and a power conditioner.

[0032]

According to the present invention, an electrical resistance between the plate-shaped member and the installation surface (the ground or the like) can be made large, and thereby it is possible to prevent the electrical corrosion of a solar cell and an electric wire due to a leakage current from the solar cell having an electrical path partly exposed and the electric wire not covered with an insulator, and to produce at a low cost a solar cell-mounting structure having high reliability for a long term. In addition to the above, the present invention can effectively prevent lateral movement of a plate-shaped member by a wind load to prevent the break of a wire and the like caused by such lateral movement.

[0033]

Further, use of a concrete member for the plate-shaped member can suppress cost increase of the rack as much as possible, and in particular use of lightweight hollow concrete can improve installation workability and easiness of construction, resulting in cost reduction.

[0034]

In addition, the plate-shaped member can be abutted against a support member to be placed on an

installation surface. Therefore, when only a support member and a plate-shaped member to be installed first are positioned properly, subsequent installation can be performed only by abutting another plate-shaped member against the support member, allowing the time for a cumbersome positioning work to be shortened.

[0035]

Furthermore, use of an adhesive for fixing the solar cell on the surface of the plate-shaped member eliminates concern for stripping of the solar cell by a wind load. In particular, use of an elastic adhesive or a double-sided tape with elasticity for fixing the solar cell allows the adhesive layer to absorb difference in the coefficient of thermal expansion between the solar cell and the plate-shaped member, resulting in the improvement of reliability. In addition, the solar cell is fixed to the plate-shaped member at a surrounding part (circumferential edge) thereof, thereby allowing easy replacement of the solar cell.

[0036]

In addition, placement of an insulating member between one side of the plate-shaped member to be brought into contact with an installation surface and the installation surface can further reduce the leak current from a solar cell having a partly exposed

cable way or a wire having no insulation coating.

[0037]

[Embodiments of the Invention]

An embodiment of the present invention will now be described below referring to FIG. 1. The present invention is not limited to this embodiment.

[0038]

FIG. 1 is a schematic side view for illustrating the solar cell-mounting structure according to the present invention. In FIG. 1, numeral 101 denotes a solar cell; 102 denotes a plate-shape member; 103 denotes a support member; 104 denotes a connection cable; 105 denotes a connection member (ring sleeve); 106 denotes the distance between racks; and 107 denotes the inclination angle of the plate-shaped member.

[0039]

As shown in FIG. 1, the solar cell 101 is fixed on the upper surface of the plate-shaped member 102. Further, the plate-shaped member 102 is installed in contact with an installation surface (such as the ground) and with the support member 103 at one side thereof, respectively. The upper solar cell-fixing surface of the plate-shaped member 102 in a certain row is in contact with the support member 103 in the next adjacent row.

[0040]

Each member for constituting the solar cell-mounting structure according to the present invention will now be described below.

[0041]

[Solar cell]

Preferably, the solar cell for use in the present invention is a thin and lightweight type. Crystals such as single-crystal silicon and polycrystalline silicon, amorphous silicon, compound semiconductors such as CIGS and CIS, and the like can be used for the photovoltaic layer of the solar cell.

[0042]

As a suitable example of the solar cell, for example, the photovoltaic element composed of amorphous silicon formed on a stainless steel substrate can be used. This construction is very convenient for manufacturing a thin and lightweight solar cell. The flexible construction also allows sticking and fixing, for example, even on the curved surface of a rack.

[0043]

Referring to FIGS. 6 and 7, the solar cell using the photovoltaic element composed of amorphous silicon formed on a stainless steel substrate will now be described.

[0044]

FIG. 6(a) is a plan view of the photovoltaic

element, and FIG. 6(b) is a sectional view taken in the line A-A' of FIG. 6(a). FIG. 7 is an example showing the resin-sealed state in which the light-receiving surface and the back surface of the photovoltaic element of FIG. 6. FIG. 7(a) is a view from the light-receiving surface side, and FIG. 7(b) is a sectional view taken in the line B-B' of FIG. 7(a).

[0045]

In FIGS. 6A, 6B, 7A and 7B, numeral 6001 denotes a stainless steel substrate; 6002 denotes a semiconductor photoactive layer; 6003 denotes a collecting electrode; 6004 denotes a positive electrode copper tab; 6005 denotes an insulating double-sided tape; 6006 denotes a negative electrode copper tab; 6007 denotes a weatherproof coating; 6008 denotes a bare copper solid wire; 7001 denotes an EVA resin; and 7002 denotes an ETFE resin.

[0046]

The solar cell as shown in FIGS. 6 and 7 can be manufactured, for example, as described below.

[0047]

An Al layer and a ZnO layer are first formed successively on a cleaned stainless steel substrate 6001 by sputtering process as a metal electrode layer (or a light-reflecting layer) for the back surface side. A semiconductor layer of amorphous silicon (a-

Si) is then formed by a plasma CVD process. Next, as a transparent conductive layer, In_2O_3 thin film is deposited by a resistance heating process to form a semiconductor photoactive layer 6002. A silver paste is then formed by screen printing or the like to form a collecting electrode 6003.

[0048]

Further, the collecting electrode 6003 is connected to the positive electrode copper tabs 6004 on both sides of the stainless steel substrate. The positive electrode copper tabs are fixed to the stainless steel substrate with an insulating double-sided tape 6005, and the negative electrode copper tabs 6006 on the back side are laser-welded to the stainless steel substrate. The weatherproof coating 6007 is applied only on the light-receiving surface side.

[0049]

Next, the bare copper solid wire 6008 for series connection of the solar cells is processed to substantial U shape to be electrically connected with the positive electrode tabs 6004 and the negative electrode tabs 6006.

[0050]

Lastly, as shown in FIG. 7, a stacked member of the ETFE resin 7002 and the EVA resin 7001 is laminated on the light-receiving surface side, and

the EVA resin 7001 on the non-light-receiving surface is laminated with a vacuum laminator. That is, in this solar cell, the bare copper solid wire 6008 as the electroactive portion is exposed.

[0051]

When a plurality of the solar cell-mounting structures according to the present invention are used to systemize the structure, the solar cells are connected in series to form a series structure in advance, thereby decreasing the connection work in the installation field to enable cost reduction.

[0052]

The solar cell according to the present invention is not limited to the above-described solar cell having the partly exposed electrocative portion.

[0053]

[Plate-shaped member]

Any plate-shaped member capable of mounting electrical parts thereon, having a certain thickness and structural strengths may basically be used for the plate-shaped member.

[0054]

FIG. 8 shows conceptual diagrams of the plate-shaped member. FIG. 8(a) is a perspective view showing the state in which the plate-shaped member 102 is installed in contact with a plate-shaped member-installing surface 805 and with a support

member 103 at one side thereof, respectively. FIG. 8(b) is a schematic expanded view showing a contact part of the plate-shaped member 102 with the plate-shaped member-installing surface 805. FIG. 8(c) is a perspective view showing an example of the shape of a surface 802 of the plate-shaped member which includes the one side in contact with the plate-shaped member-installing surface 805 and which is not abutted against a support member 103. In FIG. 8(c), numeral 801 denotes a solar cell-fixing surface of the plate-shaped member 102; 803 denotes an opposite surface of the plate-shaped member to the solar cell-fixing surface 801, the opposite surface being abutted against the support member 103; 804 denotes the one side of the plate-shaped member which is brought into contact with the plate-shaped member-installing surface 805; and 802 denotes a surface containing the one side edge 804 and is not abutted against the support member 103.

[0055]

The side 804 where the plate-shaped member-installing surface 805 is in contact with the plate-shaped member 102 typically has a certain width as shown in FIG. 8(b).

[0056]

Further, the surface 802 which includes the above-described one side 804 and is not abutted

against the support member 103 is the surface of the diagonally shaded area shown in FIG. 8(c), which may have a structure having a surface with a recess as illustrated or a structure having any uneven shape.

[0057]

As a material for the plate-shaped member 102, a concrete member is easy in handling and useful in terms of cost, structural strength and weight. When the concrete member is used, it may be formed at the installation field by assembling a mold, pouring a concrete to the mold and hardening the concrete, but it is preferable that a concrete member previously molded in a plant is conveyed into the installation field, because in the field work, hardening conditions may change depending on season, weather, a curing method and the like.

[0058]

Generally, when the scale of electric power generation for a photovoltaic power generation system is determined, the size of a solar cell-mounting structure is determined. Therefore, it is convenient that the concrete rack (plate-shaped member) is previously molded in the plant in terms of mass production. Further, when conveyed into the installation field, the plate shape gives good workability and high handling efficiency.

[0059]

A hollow concrete 9001 shown in FIG. 9(a) and a horizontal reinforcement concrete 9002 shown in FIG. 9(b) are very useful in terms of a low price, reduced weight and high strength.

[0060]

More specifically, the hollow concrete member among the construction concrete blocks provided in JISA5406 and the like is particularly preferred in terms of cost as a plate-shaped member, strength of the plate-shaped member itself, easiness of handling and the like.

[0061]

(Hollow concrete)

Concrete can be used for a structure by kneading cement, coarse aggregate, fine aggregate and water, casting them into a mold and hardening them. Portland cement, which is generally most frequently used, is composed of clinker (C_3S (alite), C_2S (belite), C_3A (aluminate phase), C_4AF (ferrite phase), $CaS_4 \cdot 2H_2O$ (gypsum dihydrate)), to which the coarse aggregate (gravel), the fine aggregate (sand) and water are added to start hydration reaction to form a hydration product (a calcium silicate hydrate (C-S-H)), calcium hydroxide and the like to bind the cement particles and the aggregate with each other to solidify. The above-described symbol C denotes CaO; S denotes SiO_2; A denotes Al_2O_3; F denotes Fe_2O_3; and H

denotes H_2O.)

[0062]

The aggregate includes a natural aggregate (river sand, sea sand, mountain sand and the like) and an artificial aggregate.

[0063]

[Support member]

The support member 103 is a member used for inclining the surface for placing a solar cell (solar cell-fixing surface 801) of the plate-shaped member 102 and abuts against the surface 803 opposite to the solar cell-fixing surface 801.

[0064]

An inexpensive and high-strength one such as a concrete block is suitably used for the support member 103. Also, use of the same member as the plate-shaped member 102 can reduce construction and material costs.

[0065]

[Adhesive]

An adhesive is used for fixing a solar cell on a plate-shaped member. The required quality includes weathering resistance, water resistance, resistance to alkalis, light resistance, elasticity, electrical insulating properties and the like. As materials, an epoxy-based adhesive and a silicone-based adhesive and the like can be used.

[0066]

When a solar cell is bonded and fixed to a plate-shaped member, the adhesive is advantageously placed at the surrounding part of the solar cell, because when the solar cell is to be replaced in future, the solar cell can be removed relatively easily by cutting the adhesion part using a cutter knife from the outside.

[0067]

[Connection cable]

The diameter of a connection cable is selected by the size of the current to a solar cell. For the material, copper is generally preferred.

[0068]

Any connection cable with or without an insulation coating is useful, but for a connection cable with an insulation coating it is necessary to peel the coating of a connecting portion (connection by a solder, ring sleeve or the like). The connection cable without an insulation coating is particularly useful in the present invention.

[0069]

[Distance between racks]

The distance between racks (the distance shown by numeral 106 in FIG. 1) is determined in consideration of the loss of the generated energy of a solar cell caused by the shadow of the plate-shaped

member 102. The distance is generally set so that the loss of the generated energy is below 1%. The larger inclination angle (the angle shown by numeral 107 in FIG. 1) of the plate-shaped member makes the larger shadow of the plate-shaped member 102 which covers the next row. This is avoided by increasing a distance between racks. The length or the direction of the support member 103 for inclining the plate-shaped member 102 is changed to place the plate-shaped member and the support member so that the rack has a calculated length or more.

[0070]

The distance between racks according to the present invention will be described referring to FIG. 5. The distance between racks 106 is defined as the distance between the uppermost part of the plate-shaped member 102a in a certain row and the lowermost end of the solar cell 101 adhered to the plate-shaped member 102b in the adjacent row.

[0071]

[Examples]

The present invention will now be described in details below based on the following examples.

[0072]

[Example 1]

FIGS. 10 and 11 are schematic views for illustrating the solar cell-mounting structure

according to the present example. FIG. 10 is a view of the mounting structure when viewed from the side. FIG. 11 is a view of a part of the mounting structure when viewed from the light-receiving surface side of the solar cell.

[0073]

In FIGS. 10 and 11, numeral 1001 denotes a solar cell; 1002 denotes a first row plate-shaped member; 1003 denotes a first row support member; 1008 denotes a second row plate-shaped member; 1009 denotes a second row support member; 1010 denotes a third row plate-shaped member; 1011 denotes a third row support member; 1012 denotes a fourth row plate-shaped member; 1013 denotes a fourth row support member; 1004 denotes a connection cable; 1005 denotes a ring sleeve; 1006 denotes the inclination angle of a plate-shaped member; 1007 denotes the distance between racks; 1016 denotes a parallel connection cable; 1017 denotes the direction of the series connection of solar cells; and 1018 denotes the direction of the parallel connection of solar cells.

[0074]

Each member for constituting the solar cell-mounting structure according to the present example will now be described in detail below.

[0075]

(Solar cell)

FIG. 12 is schematic views of the solar cell for use in the present example. FIG. 12(a) is a plan view of the solar cell, and FIG. 12(b) is a sectional view taken in the line A-A' of FIG. 12(a).

[0076]

A solar cell 1101 has a semiconductor photoactive layer 1107 formed on a metal substrate 1106, which is also a back electrode, and a collecting electrode 1105 for collecting the current generated in the semiconductor photoactive layer 1107 is disposed on the side of a light-receiving surface. A stainless steel having a thickness of 0.15 mm is herein used for the metal substrate 1106; tandem construction consisting of amorphous silicon and microcrystalline silicon is used for the semiconductor photoactive layer 1107; and for the collecting electrode 1105, a copper wire of 100 μmϕ is fixed on the semiconductor photoactive layer 1107 with a conductive paste.

[0077]

Further, the collecting electrode 1105 is connected to a copper positive electrode tab 1102 of 100 μm thick. In addition, a polyester insulating member 1104 is disposed to insure the insulation between the positive electrode tab 1102 and the metal substrate 1106.

[0078]

Furthermore, for providing weather resistance, an acryl-silicone weatherproof coating 1108 is formed on the collecting electrode 1105 to manufacture the solar cell.

[0079]

Finally, for carrying out a series-parallel work for the solar cell easily in the field, a bare copper solid wire 1109 of ϕ1.6 mm is processed to a generally U shape to be electrically connected with the positive electrode tabs 1102 and the negative electrode tabs 1103 by unleaded solder in advance.

[0080]

The solar cell of the present example comprises the metal substrate 1106 having a dimension of 240 mm × 360 mm. Further, the present solar cell has 9.21 A as Ipm.

[0081]

(Plate-shaped member, Support member)

A hollow concrete block of 390 mm × 190 mm × 100 mm thick and C-class provided in JISA5406 architectural concrete block was used for a plate-shaped member and a support member.

[0082]

(Construction method)

The procedure for manufacturing the solar cell-mounting structure according to the present example using the above-described materials will now be

described.

[0083]

(Determination of the series-parallel numbers of the solar cells)

In the present example, 40 solar cells were connected in series, and four sets of the 40-series-connected solar cells were connected in parallel to prepare one solar cell-mounting structure aggregate. As shown in FIG. 11, since three plate-shaped members are used for two solar cells, the number of the plate-shaped members required was 240 from the calculation as follows: 40 in series ÷ 2 × 3 = 60, which 60 are required for four parallel rows. Further, 116 pieces of the support members similar to the plate-shaped member were used and installed in a direction of intersecting the direction of the plate-shaped members at 90 degrees, as shown in FIG. 10.

[0084]

(Determination of the inclination angle of the plate-shaped member, positioning and arrangement (method for applying an adhesive))

In the present example, the inclination angle of the plate-shaped member was set at 16°. The point at 34.74° north latitude and 135.8° east longitude was selected for the location of the installation. The distance between racks, in which the loss of the generated energy of a solar cell relative to the

annual generated energy is below 1%, was calculated to be 160 mm from the annual solar radiation data of the location. The distance between racks of the present example (the distance shown by numeral 1007 in FIG. 10) is about 212 mm, thus a sufficient distance between racks being maintained. The sequence of the installation is described using FIGS. 10 and 11.

[0085]

First, the first row support member 1003 is placed on a predetermined location of the ground 1014. Next, the first row plate-shaped member 1002 is placed abutting against the first row support member 1003, and installed so that a solar cell-fixing surface has 16° as measured by a gradient meter.

[0086]

Next, the second row plate-shaped member 1008 and the second row support member 1009 are installed. The support member 1009 is first placed under the plate-shaped member 1008 such that the upper part of the surface 1015 of the second row plate-shaped member 1008, which includes the side in contact with the ground 1014 but is not abutted against the support member 1009 is brought into contact with the first row support member 1003. Then, the adjustment is made by a gradient meter so that the second row plate-shaped member 1008 is in contact with the first

row support member 1003 and the second row plate-shaped member 1008 has an inclination angle of 16°.

[0087]

Similarly, the third row plate-shaped member 1010, the third row support member 1011, the fourth row plate-shaped member 1012, and the fourth row support member 1013 are installed in this sequence.

[0088]

Next, required numbers of racks were installed in the direction of the depth of the paper in FIG. 10 along the racks (the plate-shaped member and the support member) which had been first installed. Workability is very good, because the installation may be carried out by just following the plate-shaped member already installed in the first row with a desired inclination angle.

[0089]

The support member and the plate-shaped member are installed in contact with each other, so that no mark or line is needed on the ground or the like (only needed for the first installation), which further improves the workability.

[0090]

(Sticking of a solar cell, a sticking position and the sequence for sticking)

Next, a solar cell was stuck on an installed plate-shaped member with an elastic adhesive. The

adhesive was not applied on the whole back surface metal substrate of the solar cell, but its suitable amount was applied on five points including four corners and the center of the back surface metal substrate, and pressed to be stuck to the plate-shaped member.

[0091]

The sticking position of the solar cell was selected so that the solar cell is positioned at the center of the plate-shaped member when mounted, as shown in FIGS. 10 and 11.

[0092]

(Series-parallel connection work between solar cells)

Next, the series-parallel connection work between solar cells will be described referring to FIG. 11. As shown in FIG. 11, the copper solid wires of ϕ 1.6 mm, which are soldered to the positive electrode tabs and the negative electrode tabs of the solar cell, are crimped with a ring sleeve 1005 in a direction of series connection (in a direction of an arrow 1017 in FIG. 11) by using a tailored press-bonding tool to complete the series work.

[0093]

One bypass diode was connected in parallel for two series of a solar cell parallel group. The bypass diode having the rating of 100 A was selected for connection in consideration of the maximum

current calculated as follows: maximum 9.21 × 4 in parallel = 36.84 A.

[0094]

For connecting as described above, one parallel connection cable 1016 for two series of solar cells of a solar cell parallel group was connected with the cable 1016 of the next row solar cell parallel group with a ring sleeve 1005.

[0095]

[Example 2]

In the present example, the inclination angle of a plate-shaped member, the distance between racks (direction of a support member) and the construction of a solar cell were changed from the solar cell-mounting structure of Example 1.

[0096]

FIG. 13 is a side view of the solar cell-mounting structure of the present example. In FIG. 13, numeral 1201 denotes a solar cell; 1202 denotes a plate-shaped member; 1203 denotes a support member; 1204 denotes a connection cable; 1205 denotes a connection member (ring sleeve); 1206 denotes the distance between racks; and 1207 denotes the inclination angle of the plate-shaped member.

[0097]

(Solar cell)

FIG. 13 are schematic views of the solar cell

for use in the present example. FIG. 14(a) is a plan view of the solar cell, and FIG. 14(b) is a sectional view taken in the line B-B' of FIG. 14(a).

[0098]

A solar cell 1301 has a semiconductor photoactive layer 1307 formed on a metal substrate 1306, which is also a back electrode, and a collecting electrode 1305 for collecting the current generated in the semiconductor photoactive layer 1307 is disposed on the side of a light-receiving surface. A stainless steel having a thickness of 0.15 mm is used for the metal substrate 1306; tandem construction consisting of amorphous silicon and microcrystalline silicon is used for the semiconductor photoactive layer 1307; and for the collecting electrode 1305, a copper wire of 100 μmϕ is fixed on the semiconductor photoactive layer 1307 with a conductive paste.

[0099]

Further, the collecting electrode 1305 is connected to a copper positive electrode tab 1302 of 100 μm thick. In addition, a polyester insulating member 1304 is disposed to insure the insulation between the positive electrode tab 1302 and the metal substrate 1306.

[0100]

Furthermore, for providing weather resistance,

an acryl-silicone weatherproof coating 1308 was formed on the collecting electrode 1305.

[0101]

For carrying out a series-parallel work for the solar cell easily in the field, a bare copper solid wire 1309 of ϕ1.6 mm is processed to an almost U shape to be electrically connected with the positive electrode tab 1302 and the negative electrode tab 1303 by unleaded solder in advance.

[0102]

In addition, the light-receiving surface and a non-light-receiving surface of the solar cell were sealed with a laminate of an ETFE resin 1311 and an EVA resin 1310 and with an EVA resin 1310 of 460 μm thick, respectively, by a vacuum laminator to manufacture a solar cell.

[0103]

The solar cell of the present example comprises the metal substrate 1306 having a dimension of 240 mm × 360 mm and the coating material (EVA resin 1310) having a dimension of 260 mm × 370 mm. Further, the present solar cell has an Ipm of 9.21 A.

[0104]

(Plate-shaped member, Support member)

These members are the same as those of Example 1, so that description will be omitted.

[0105]

(Construction method)

The procedure for manufacturing the concrete mounting structure with the solar cell of the present example using the above-described materials will now be described.

[0106]

(Determination of the series-parallel numbers of the solar cells)

In the present example, 40 solar cells were connected in series, and four set of the 40-series-connected solar cells were connected in parallel to prepare one solar cell-mounting structure aggregate.

(Determination of the inclination angle of the plate-shaped member, positioning and arrangement (method for applying an adhesive))

[0107]

In the present example, the inclination angle of the plate-shaped member was set at 25°. The point at 34.74° north latitude and 135.8° east longitude was selected for the location of the installation. The distance between racks, under the conditions that the loss of the generated energy of a solar cell relative to the annual generated energy is below 1%, was calculated to be 266 mm from the annual solar radiation data of the location.

[0108]

In the present example, since three plate-

shaped members are used for two solar cells, similar to Example 1, the number of the plate-shaped members required was 240 from the calculation as follows: 40 in series ÷ 2 × 3 = 60, which 60 are required for four rows. Further, the support members of 240 pieces were used, which is the same number as the plate-shaped members as shown in FIG. 13.

[0109]

In the present example, as the inclination angle is larger than 16° of Example 1, the direction for installing the support member 1203 is the same as the direction of the plate-shaped member 1202 as shown in FIG. 13. The distance between racks (distance shown by numeral 1206 in FIG. 13) of the present example is about 315 mm, maintaining a sufficiently necessary distance between racks, since the support member 1203 was arranged in the same direction as that of the plate-shaped member 1202.

[0110]

The sequence for installing the support member 1203 and the plate-shaped member 1202 is the same as Example 1, so that the description will be omitted.

[0111]

(Sticking of a solar cell, a sticking position and the sequence for sticking)

Next, a solar cell was stuck on an installed plate-shaped member with an elastic adhesive. The

adhesive was not applied on the whole back surface EVA of the solar cell, but its suitable amount was applied on five points including four corners and the center, and pressed to be stuck to the plate-shaped member.

[0112]

When sticking, a primer (undercoat agent) was applied to improve the EVA surface, on which the elastic adhesive was applied.

[0113]

The sequence for sticking the solar cell is similar to that in Example 1.

[0114]

(Series-parallel connection work between solar cells)

The description will be omitted as the work is similar to that in Example 1.

[0115]

(Connection of bypass diode)

The description will be omitted as the work is similar to that in Example 1.

[0116]

[Example 3]

In the present example, the surface for installing a plate-shaped member was a concrete surface. FIG. 15 is a side view of the solar cell-mounting structure of the present example. In FIG. 15, numeral 1401 denotes a solar cell; 1402 denotes a

plate-shaped member; 1403 denotes a support member; 1404 denotes a connection cable; 1405 denotes a connection member (ring sleeve); 1406 denotes the distance between racks; 1407 denotes the inclination angle of the plate-shaped member; 1408 denotes an insulating member; and 1409 denotes a concrete surface which is a plate-shaped member installing-surface.

[0117]

In the present example, a rubber 1408, which is an insulating member having a thickness of 5 mm and a width of 50 mm, was placed between the side 1410 of the plate-shaped member 1402 to be brought into contact with the concrete surface 1409, and the concrete surface 1409 and between the support member 1403 and the concrete surface 1409, in order to further reduce the leak current to the non-insulation cable way of the solar cell and to the concrete surface 1409, in addition to the state of Example 1. The rubber material includes silicon, EPDM and the like.

[0118]

By placing the insulation member 1408 such as a rubber material, when the concrete surface 1409 is wet by a rain fall, friction strength may be reduced compared with the case in which the plate-shaped member 1402 is in direct contact with the concrete

surface 1409, and the possibility of lateral movement of the plate-shaped member 1402 may be increased.

[0119]

This is the phenomenon that the friction strength between the insulation member such as a rubber and the concrete becomes smaller than that between the plate-shaped member and the insulation member, and the strength required for the lateral movement is reduced compared with the case in which the plate-shaped member is in direct contact with the concrete installation surface.

[0120]

On the other hand, like the present invention, the upper part of the solar cell-fixing surface of the plate-shaped member 1402 in a certain row can be placed so as to abut against the support member 1403 in the next adjacent row to effectively prevent the above-described lateral movement.

[0121]

[Example 4]

This is the example in which the solar cell-mounting structures of Example 1 (40 in series and 4 in parallel) are used to construct a photovoltaic power generation system. FIG. 16 is a schematic view of the solar cell array of the present example. In the present example, four sets of the solar cell-mounting structures of Example 1 are used to be

connected in parallel in a connection box.

[0122]

In FIG. 16, numeral 1501 denotes a solar cell-mounting structure; 1502 denotes a wire; 1503 denotes a connection box (pedestal box); 1504 denotes an isolation transformer; 1505 denotes a power conditioner; 1506 denotes a ground point; 1507 denotes a bypass diode; 1508 denotes a switch; and 1509 denotes a blocking diode.

[0123]

Wiring as shown in FIG. 16 allows the photovoltaic power generation system to be constructed using the solar cell-mounting structure according to the present invention. In the present system, the electric power generated at the solar cell-mounting structure 1501 is combined in the connection box 1503 to be converted from direct current to alternate current by the power conditioner 1505 and used for electric power.

[0124]

In the present system, the end of the positive electrode was grounded to make the voltage to ground of the solar cell to negative, thereby giving cathode corrosion protection.

[0125]

[Effect of the Invention]

According to the simple mounting structure of

the present invention, an electrical resistance between the plate-shaped member and the installation surface (the ground or the like) can be made large, and thereby it is possible to prevent the electrical corrosion of a solar cell and an electric wire due to a leakage current from the solar cell having an electrical path partly exposed and the electric wire not covered with an insulator, and to produce at a low cost a solar cell-mounting structure having high reliability for a long term. In addition to the above, it can effectively prevent lateral movement of a plate-shaped member by a wind load to prevent the break of a wire and the like caused by such lateral movement.

[0126]

Further, use of a concrete member for the plate-shaped member can suppress cost increase of the rack as much as possible, and in particular use of lightweight hollow concrete can improve installation workability and easiness of construction, resulting in cost reduction.

[0127]

In addition, the plate-shaped member can be abutted against a support member to be placed on an installation surface. Therefore, when only the support member and the plate-shaped member to be installed first are positioned properly, subsequent

installation can be performed only by abutting the plate-shaped member against the support member, allowing the time for a cumbersome positioning work to be shortened.

[0128]

Furthermore, use of an adhesive for fixing the solar cell on the surface of the plate-shaped member eliminates concern for stripping of the solar cell by a wind load. In particular, use of an elastic adhesive or a double-sided tape with elasticity for fixing the solar cell allows the adhesive layer to absorb difference in the coefficient of thermal expansion between the solar cell and the plate-shaped member, thereby resulting in the improvement of reliability. In addition, the solar cell is fixed to the plate-shaped member at the surrounding part (circumferential edge), thereby allowing easy replacement of the solar cell.

[0129]

In addition, placement of an insulating member between one end of the plate-shaped member to be brought into contact with an installation surface and the installation surface can further reduce the leak current from a solar cell having a partly exposed cable way or a wire having no insulation coating, thereby allowing construction of a solar cell-mounting structure, a solar cell array and a

photovoltaic power generation system having extremely high efficiency and reliability.

[Brief Description of the Drawings]

[FIG. 1]

A schematic view showing a solar cell-mounting structure according to an embodiment of the present invention

[FIG. 2]

Schematic views of a conventional mounting structure with a rack-mounted photovoltaic element

[FIG. 3]

A schematic view of a conventional concrete rack tailored for a solar cell

[FIG. 4]

A conceptual diagram for explaining a wind load acting on a plate-shaped member

[FIG. 5]

A view illustrating a distance between racks

[FIG. 6]

Views showing an example of the solar cell for use in the present invention

[FIG. 7]

Views showing an example of the solar cell for use in the present invention

[FIG. 8]

Conceptual diagrams of the plate-shaped member

for use in the present invention

[FIG. 9]

Schematic views showing an example of the concrete member suitable for use in the present invention

[FIG. 10]

A side view schematically showing a part of the solar cell-mounting structure of Example 1

[FIG. 11]

A plan view schematically showing a part of the solar cell-mounting structure of Example 1

[FIG. 12]

Schematic views of the solar cell used in the solar cell-mounting structure of Example 1

[FIG. 13]

A side view schematically showing a part of the solar cell-mounting structure of Example 2

[FIG. 14]

Schematic views of the solar cell used in the solar cell-mounting structure of Example 2

[FIG. 15]

A side view schematically showing a part of the solar cell-mounting structure of Example 3

[FIG. 16]

A schematic diagram of the photovoltaic power generation system of Example 4

[Description of Reference Characters]

101, 402, 1001, 1101, 1201, 1301, 1401: Solar cell

102, 403, 1002, 1008, 1010, 1012, 1202, 1402: Plate-shaped member

103, 406, 1003, 1009, 1011, 1013, 1203, 1403: Support member

104, 1004, 1016, 1204, 1404; Connection cable

105, 1005, 1205, 1405: Connection member (ring sleeve)

106, 1007, 1206, 1406: Distance between racks

107, 1006, 1207, 1407: Inclination angle of plate-shaped member

401: Wind

404: Side surface of plate-shaped member with respect to solar cell-fixing surface

407, 805, 1014: Installation surface of plate-shaped member

408: Wind load

409, 801: Solar cell-fixing surface of plate-shaped member

802: Surface including one side of plate-shaped member in contact with plate-shaped member-installation surface, and not being in contact with supporting member

803: Surface of plate-shaped member opposite to solar cell-fixing surface

804: One side of plate-shaped member in contact

with plate-shaped member-installation surface

1017: Direction of series connection of solar cells

1018: Direction of parallel connection of solar cells

1102, 1302, 6004: Positive electrode tab

1103, 1303, 6006: Negative electrode tab

1104, 1304, 6005: Insulating member

1105, 1305, 6003: Collecting electrode

1106, 1306, 6001: Metal substrate

1107, 1307, 6002: Semiconductor photoactive layer

1108, 1308, 6007: Weatherproof coating

1109, 1309, 6008: Bare copper solid wire

1310, 7001: EVA resin

1311, 7002: ETFE resin

1408: Insulating member

1409: Concrete surface

1501: Solar cell-mounting structure provided with solar cell

1502: Wiring

1503: Connection box (pedesta box)

1504: Insulation transformer

1505: Power conditioner

1506: Ground point

1507: Bypass diode

1508: Switch

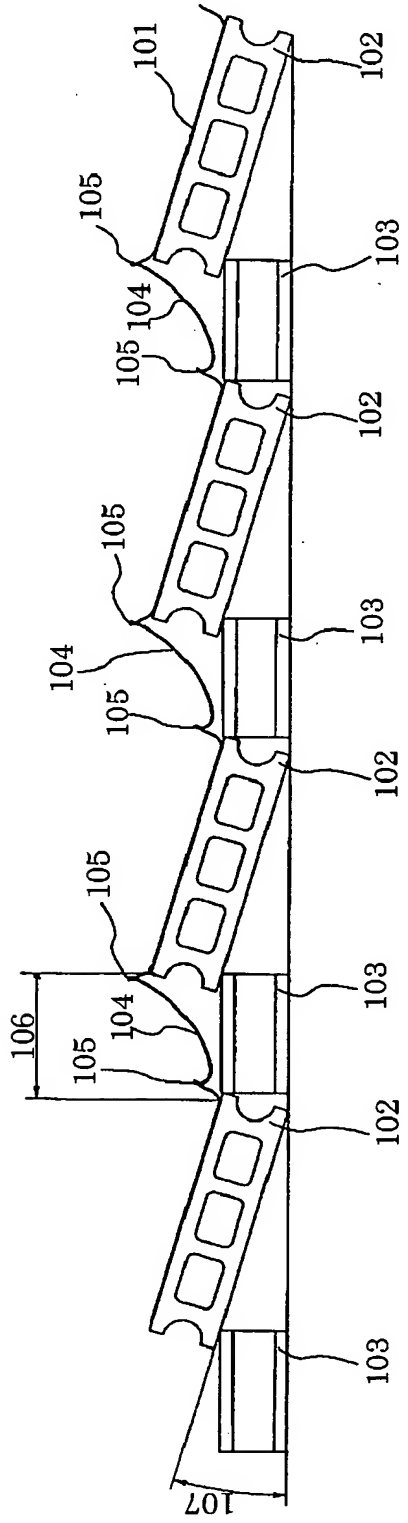
1509: Reverse flow-blocking diode

9001: Hollow concrete

9002: Horizontal reinforcement concrete

【書類名】　図面

【図１】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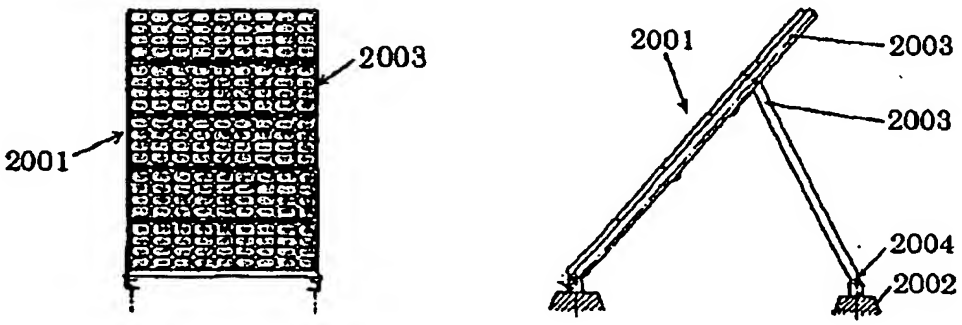

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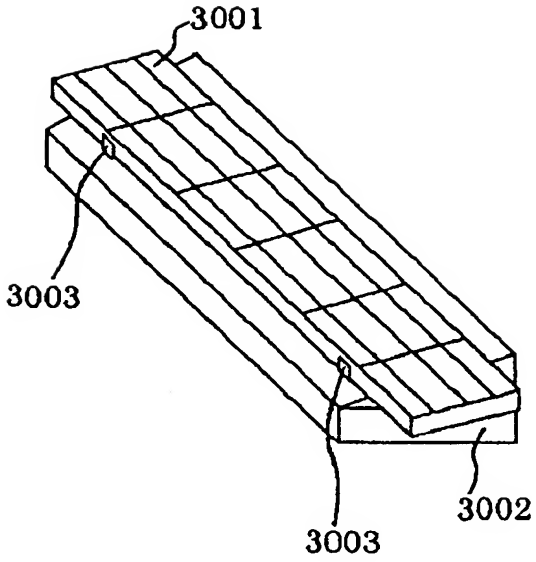

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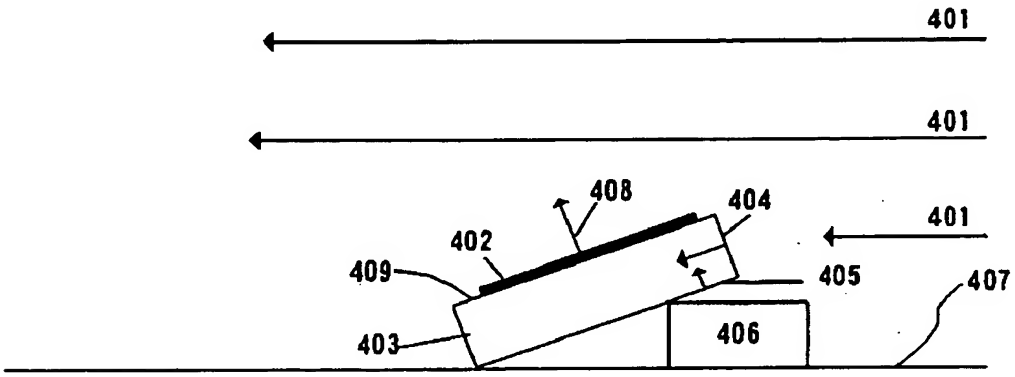
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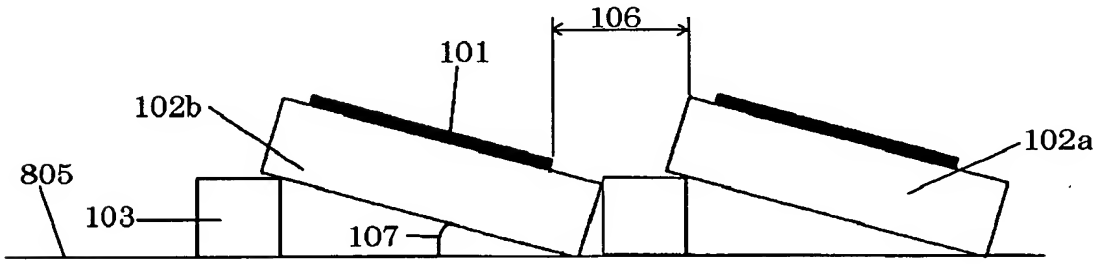
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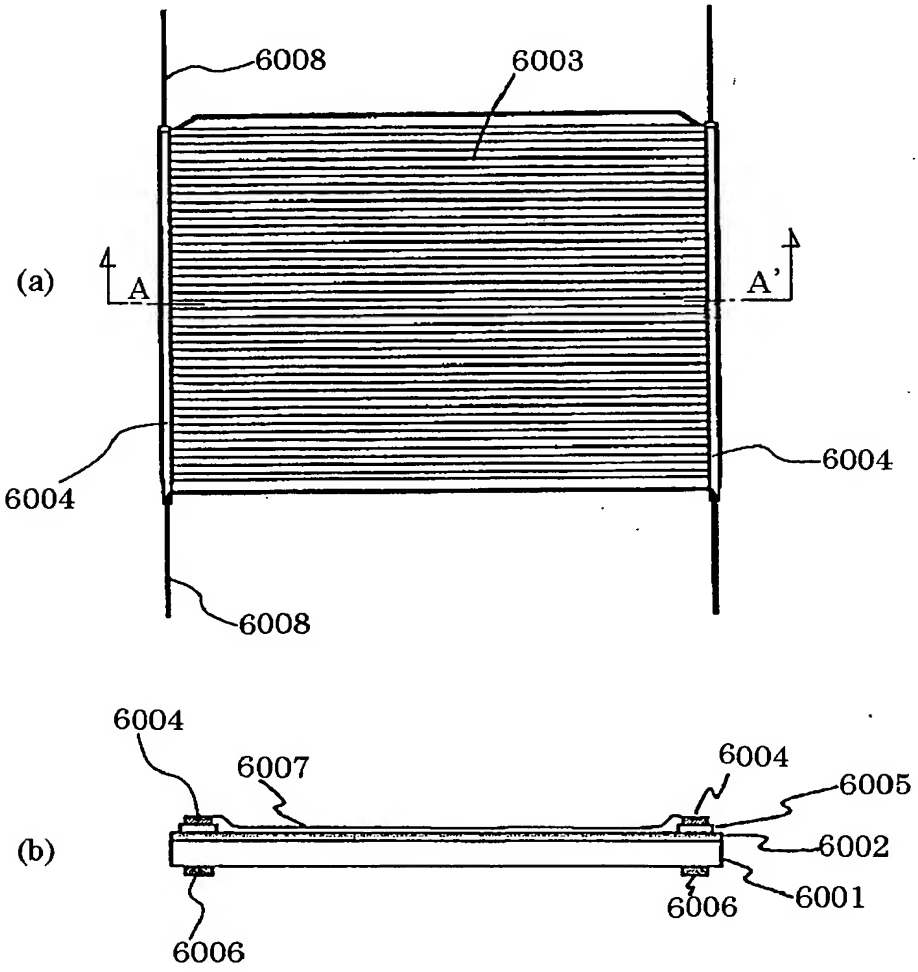
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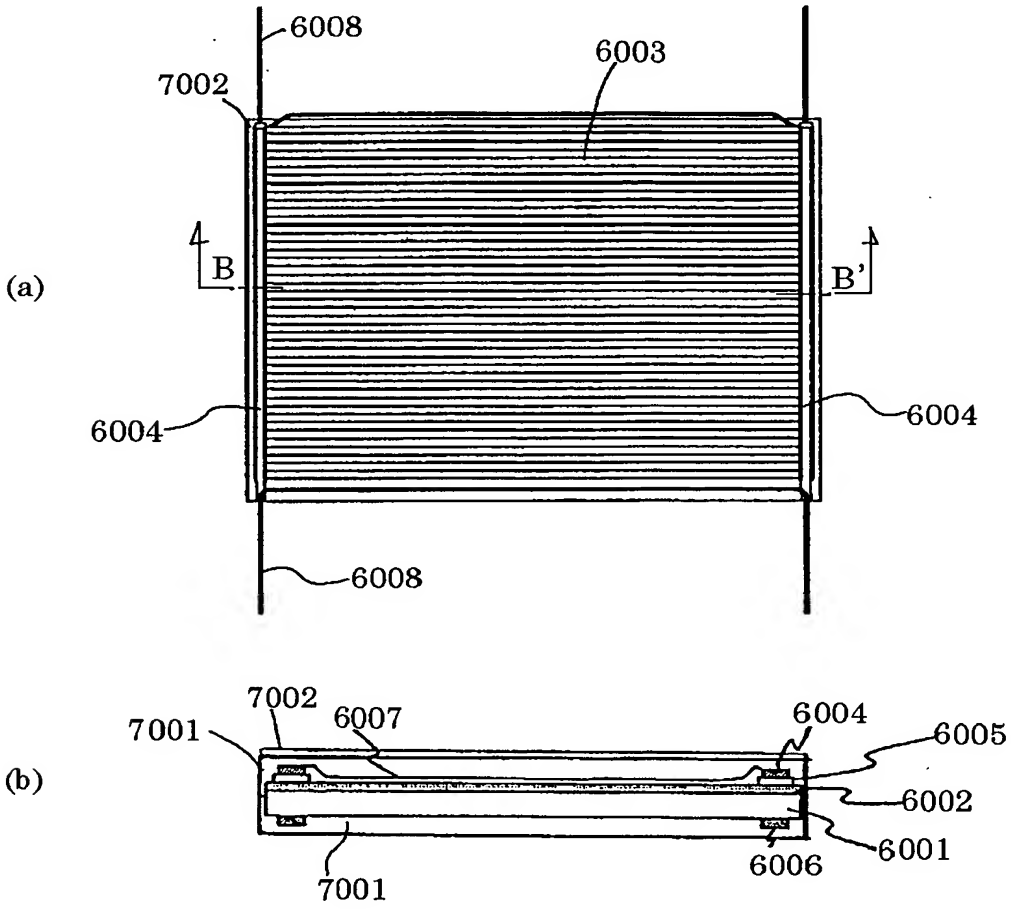
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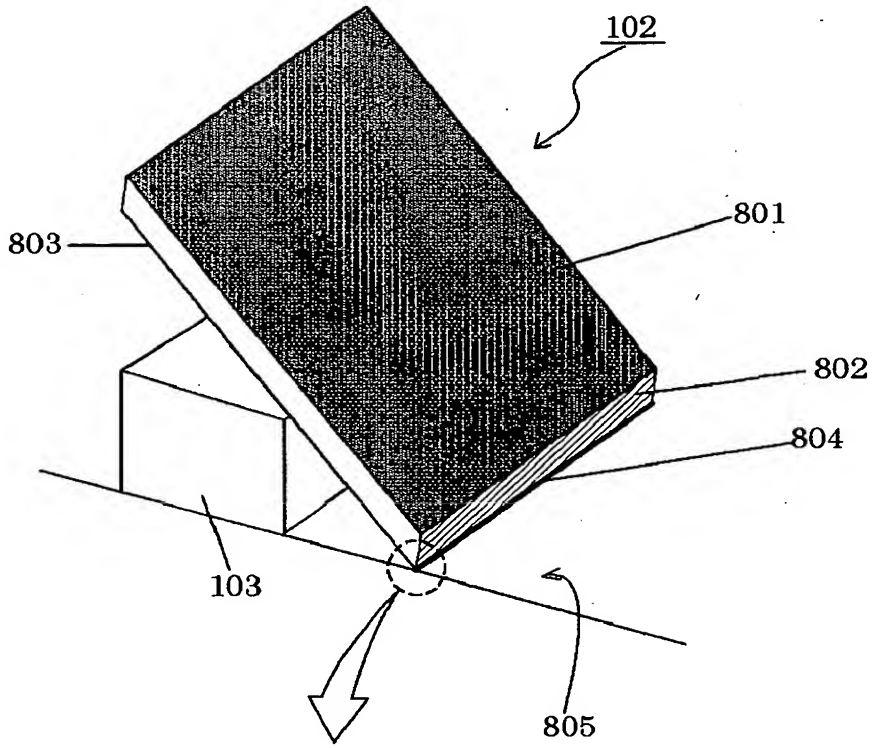

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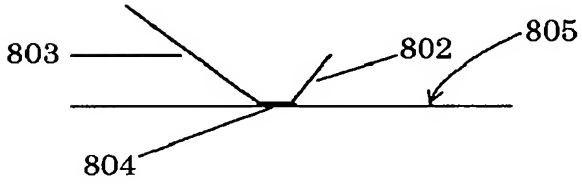

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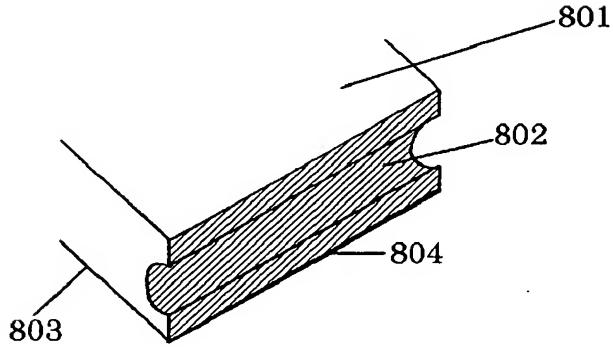

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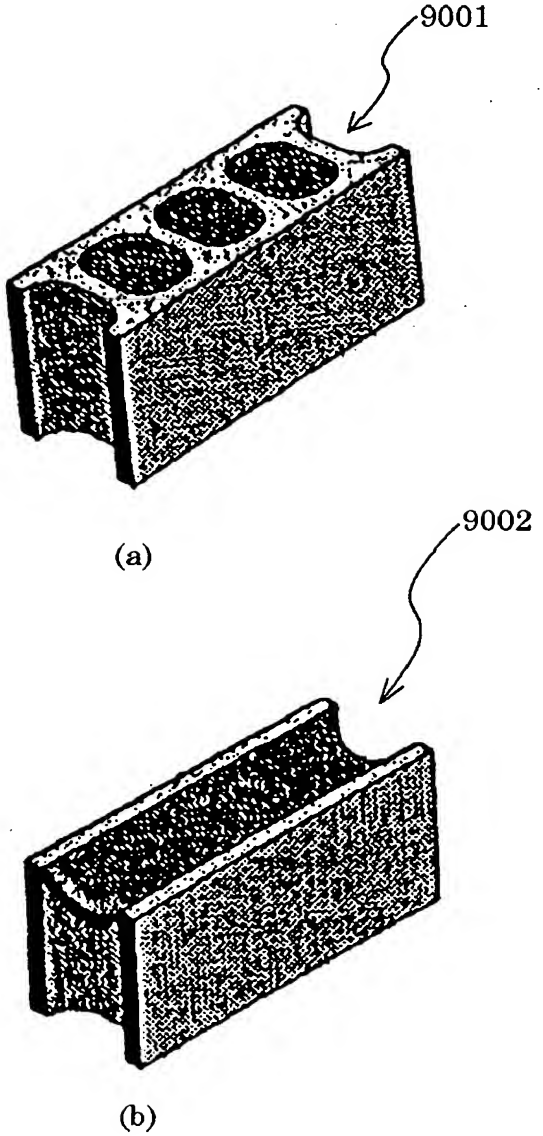

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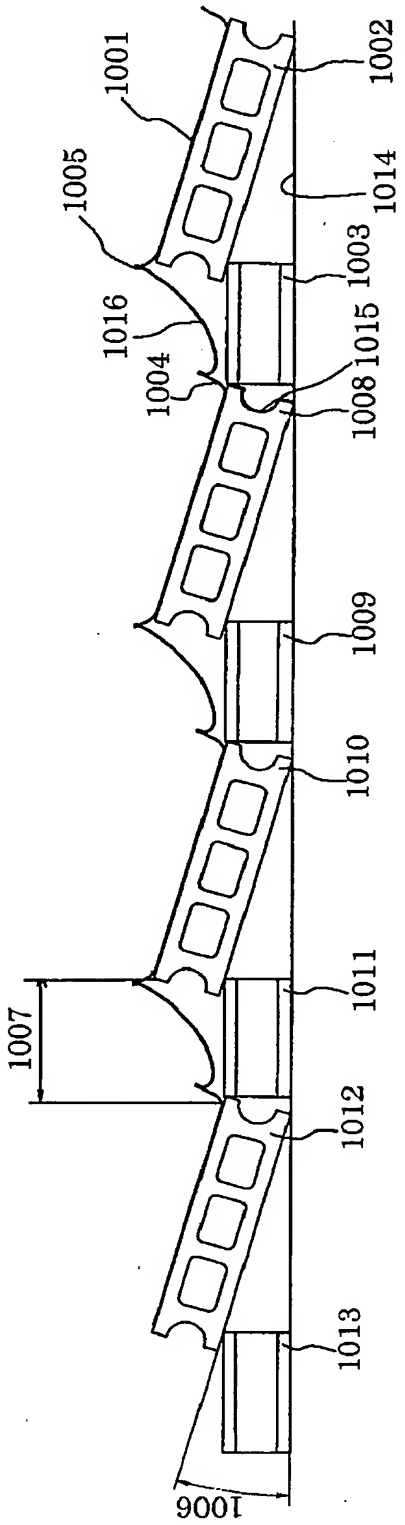
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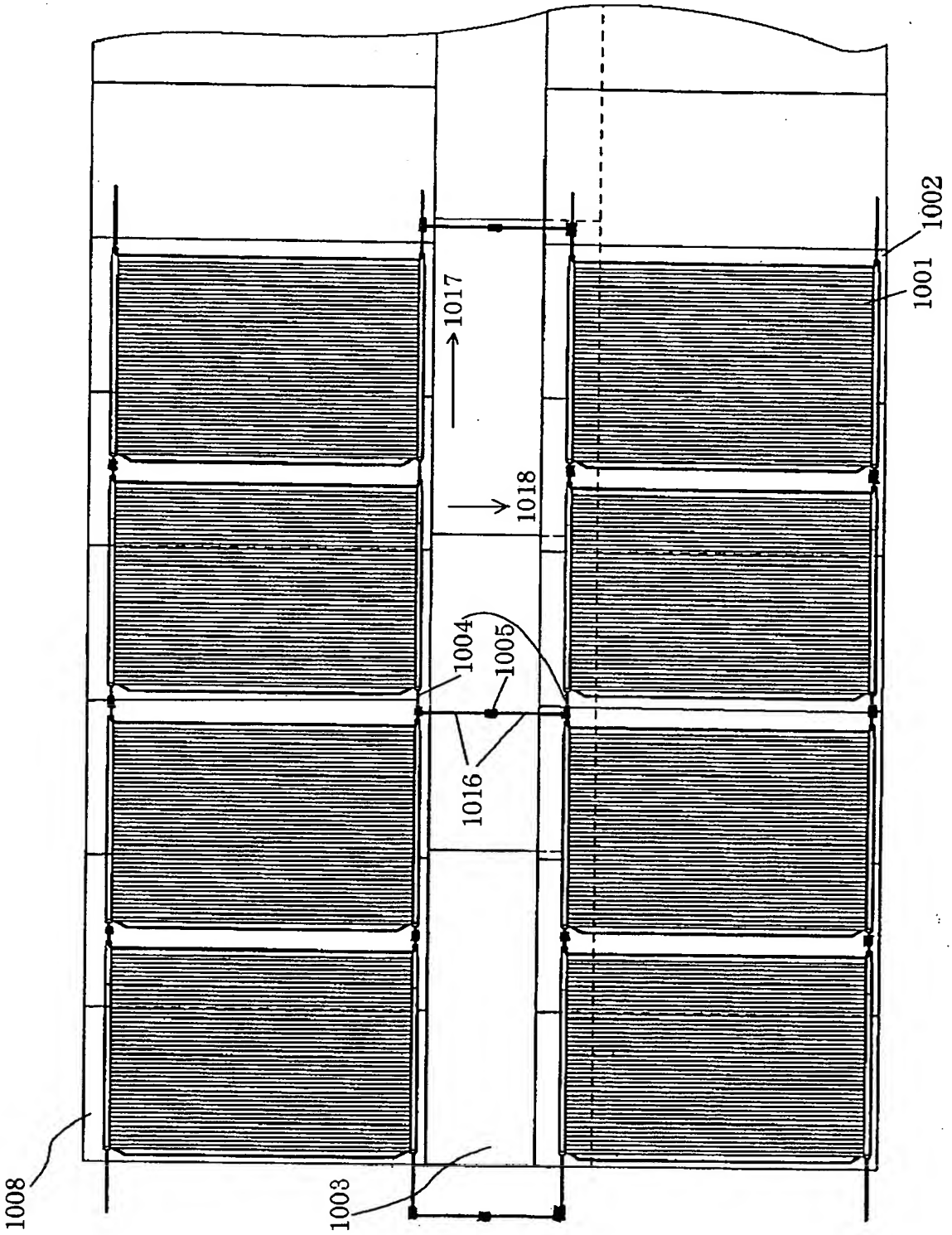
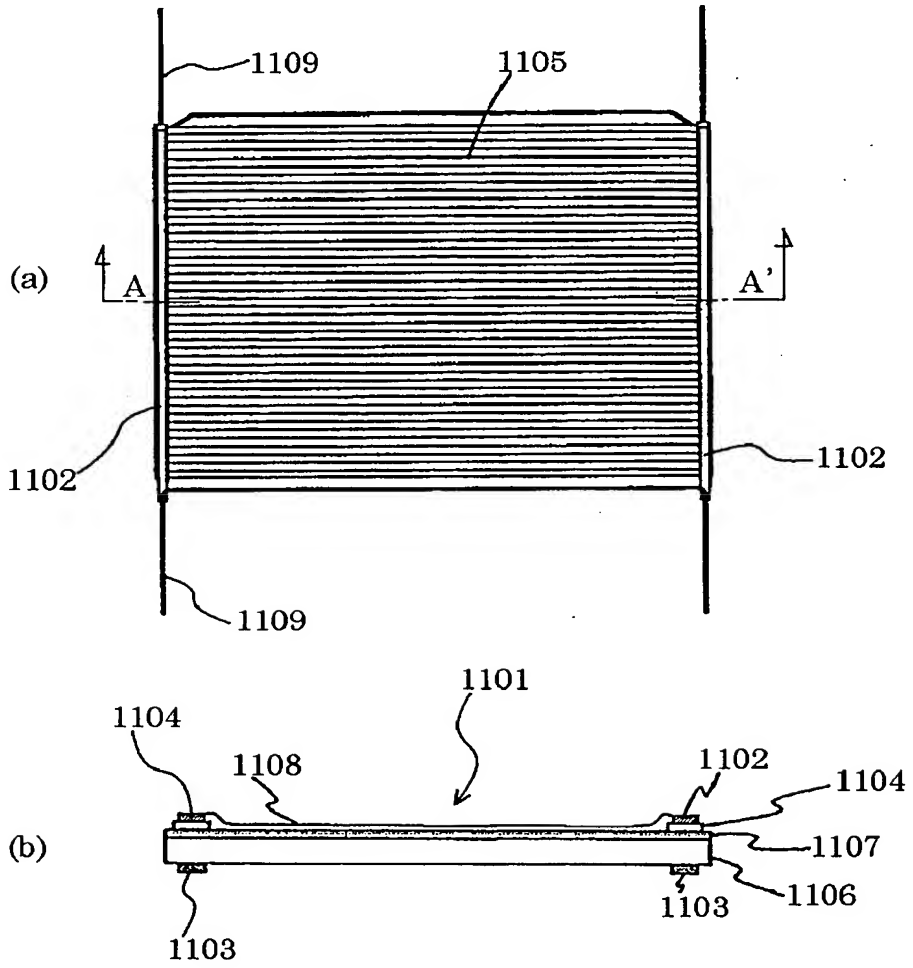
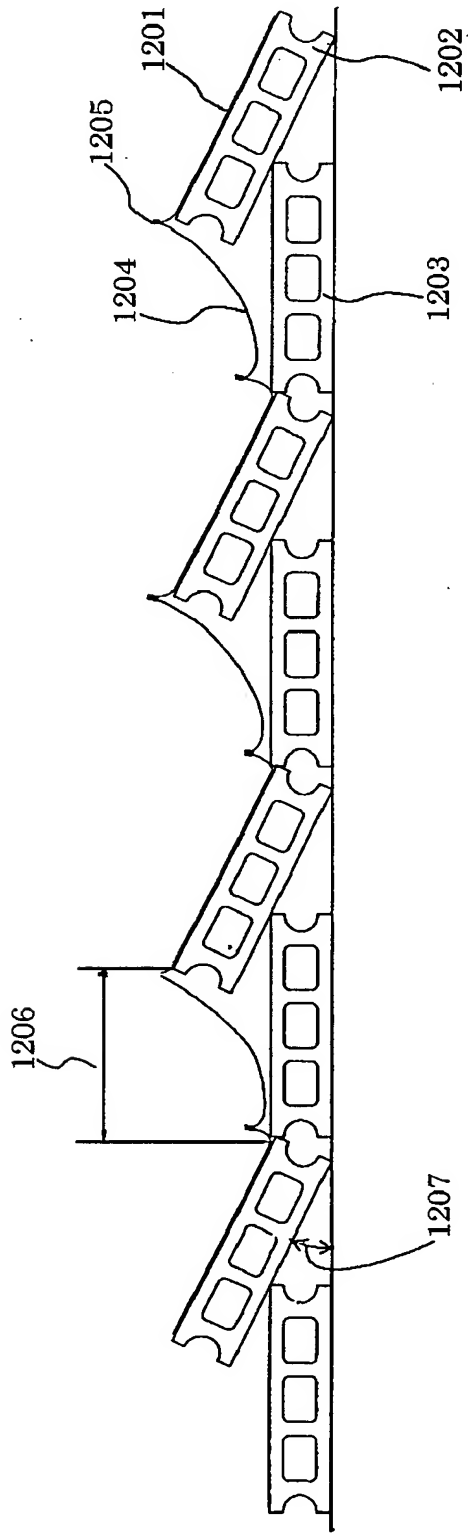


【図１２】

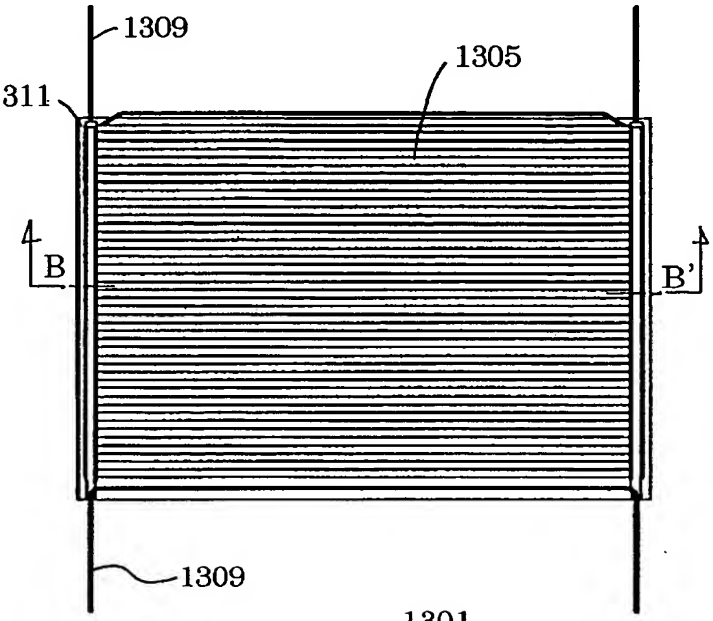

(a)
1109
1105
A
A'
1102
1102
1109
(b)
1101
1104
1108
1102
1104
1107
1106
1103
1103

【図１３】

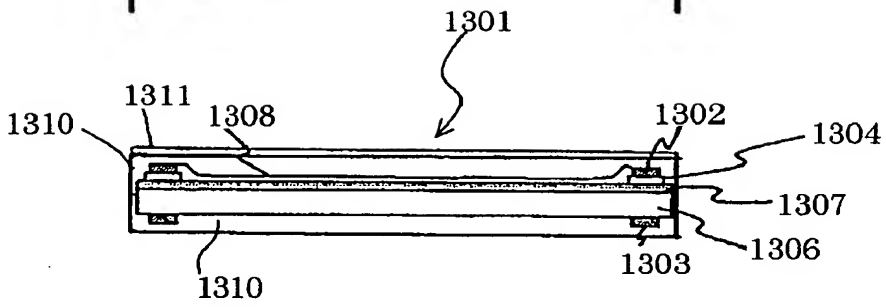


【図１４】

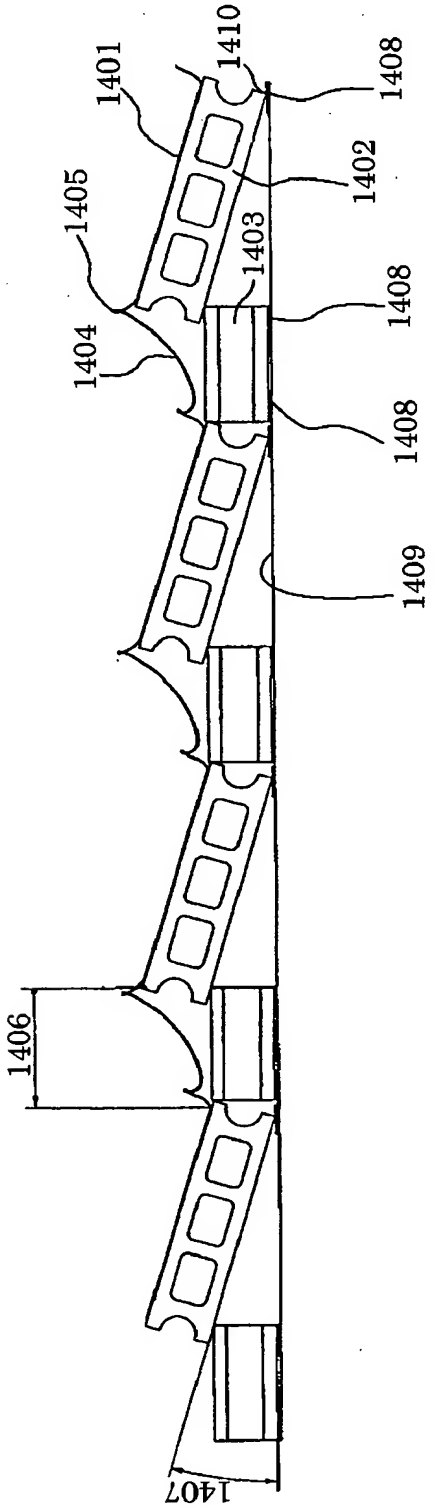
(a)


1309
1305
1311
B
B'
1309

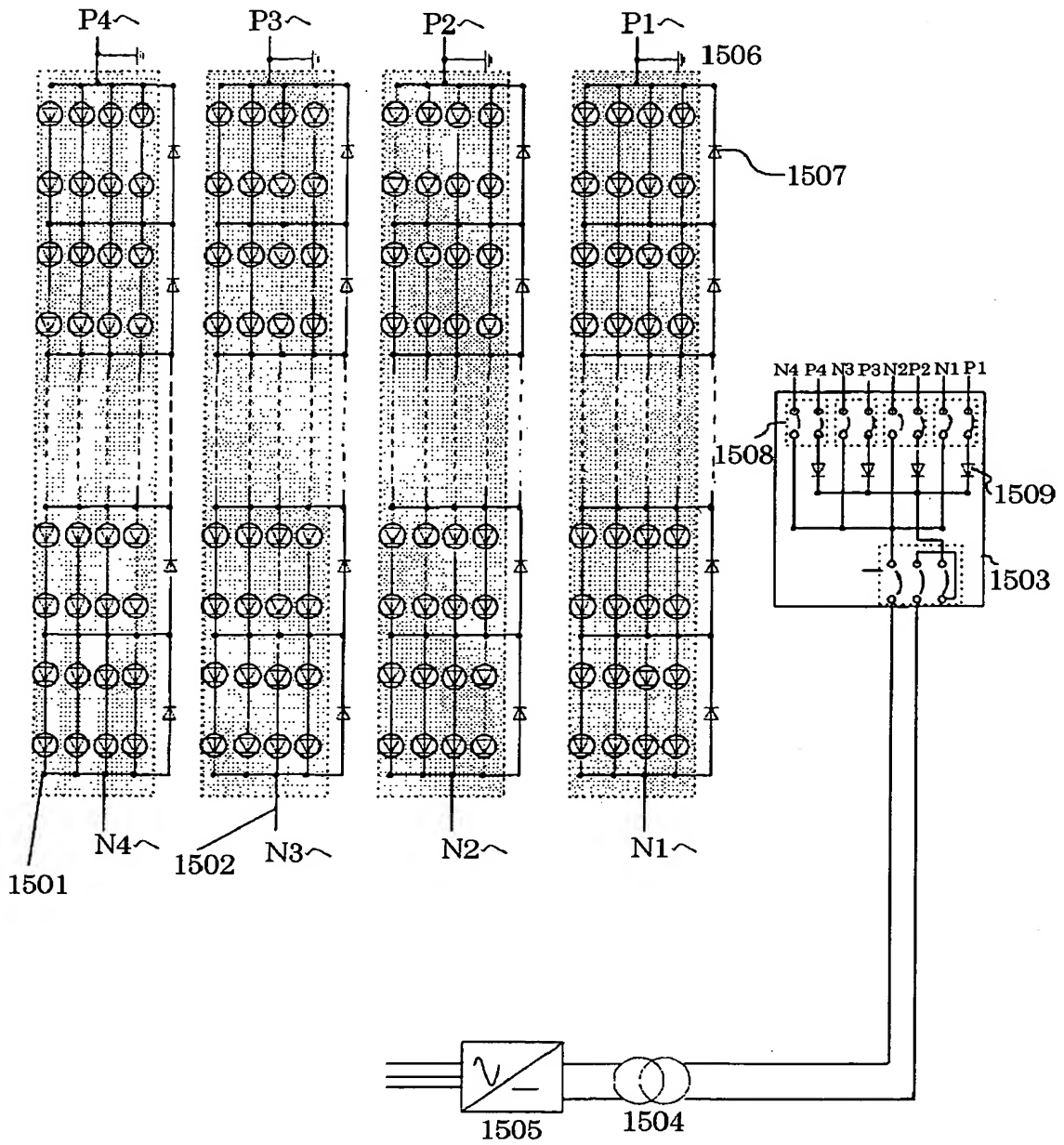
(b)


1301
1311
1310
1308
1302
1304
1307
1306
1303
1310

【図１５】



【図１６】


P4へ
P3へ
P2へ
P1へ
1506
1507
N4 P4 N3 P3 N2 P2 N1 P1
1508
1509
1503
N4へ
N3へ
N2へ
N1へ
1501
1502
1505
1504

[DOCUMENT NAME] ABSTRACT

[ABSTRACT]

[Object] The object of the present invention is to provide a solar cell-mounting structure which can prevent the life of a solar cell and an electric wire from being shortened by an electrochemical reaction due to a leakage current from the solar cell having an electrical path partly exposed and the electric wire with no insulation coating, and which can effectively prevent movement of a plate-shaped member by a wind load to prevent the break of a wire.

[Solving means] The solar cell-mounting structure is characterized in that a solar cell 101 is fixed on one surface of a plate-shaped member 102, the plate-shaped member 102 is placed on an installation surface so that one side of the plate-shaped member is in contact with the installation surface, a surface of the plate-shaped member 102 opposite to the solar cell-fixing surface is in contact with a first support member 103, and out of surfaces including the one side of the plate-shaped member 102, at least a part of the surfaces in no contact with the first support member 103 is in contact with a second support member 103.

[Selected drawing] Figure 1